PART I

Multiple choice questions (MCQ)-Select one correct answer and label it on the corresponding score sheet.

1. Choose the correct statement about the element: $^{23}_{11}Na$
   A. An atom of the element contains 12 electrons.
   B. The atomic number of the element is 23.
   C. The mass number of the element is 11.
   D. The element is placed in the first period of the periodic table.
   E. An atom of the element contains 12 neutrons.

2. Which line shows the following atoms in order of decreasing atomic radius?

$$_{6}C\ ,\ _{15}P\ ,\ _{7}N$$

   A. N > C > P
   B. P > N > C
   C. P > C > N
   D. N > P > C
   E. C > N > P

3. What is the oxidation number for sulfur in H_2SO_4?
   A. -4
   B. +3
   C. +4
   D. -6
   E. +6

4. Which statement is true for iodine?
   A. it is the most reactive halogen
   B. it consists of nonpolar, diatomic molecules
   C. it is a liquid at room temperature
   D. it has higher electronegativity than bromine
   E. it is not soluble in water at all

5. Two elements chemically combined defines:
   A. a homogeneous mixture
   B. a heterogeneous mixture
   C. a solution
   D. a compound
   E. none of these

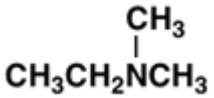
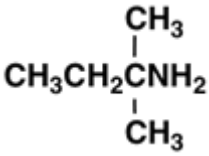
6. Solubility of nitrogen in water decreases upon:
   A. increasing the pressure
   B. increasing the temperature
   C. increasing the volume of the solvent
   D. all of them are correct
   E. none of them are correct

7. For which of the compounds below are *cis-trans* isomers possible?

$CH_3CH=CH_2$ (1) $CH_3CH=CHCH_2CH_3$ (2) $CH_3CH=CHCH_3$ (3)

   A. only 2
   B. both 1 and 2
   C. both 2 and 3
   D. all three
   E. only 3

8. Which compound is a tertiary amine?

A.	B.	C.	D.	E.
$(CH_3)_3CNH_2$			$(CH_3CH_2)_2NH$	$(CH_3)\ NH_3^+$

9. The name of the following groups are:

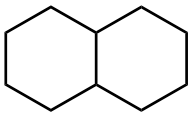
$-NO_2$ $-OH$ $-C_2H_5$ $-NH_2$

   A. nitro, aldehyde, ethyl, cyano
   B. nitro, hydroxyl, ethyl, amino
   C. amino, hydroxyl, benzyl, nitro
   D. cyano, oxo, methyl, amino
   E. amino, aldehyde, ethyl, nitro

10. The reaction type characteristic for alkanes is:
   A. addition
   B. substitution
   C. decarboxylation
   D. isomerization
   E. polymerization

Section I.A

1. Fill in the following table. **(5)**

Name of the compound		nitrous acid		ethanal	formic acid
Structure of the compound	$AlCl_3$				

Section I.B

1. Carry out the following conversions: **(2)**

5×10^{11} mg =…… Mg

0.008 cm^3 = ……. mm^3

2. Match each of the following chemical terms with the **BEST** definition chosen from the given pool. **(3)**

A. unsaturated compound ……

B. condensation ……

C. reducing agent ……

a. a compound that contains only carbon and hydrogen
b. a compound that contains only carbon and hydrogen, and has only single bonds
c. the conversion of a liquid to a solid
d. a substance that causes a reduction by donating an electron
e. the direct conversion of a gas to a solid
f. an organic molecule that contains a double or triple bond
g. the conversion of a gas to a liquid
h. a substance that causes a reduction by accepting an electron
i. a substance that is reduced by accepting an electron

PART II

Multiple choice questions (MCQ)-Select one correct answer and label it on the corresponding score sheet.

11. Give the expected ground-state electron configuration for the ion: $^{32}_{16}S^{2-}$.
    A. $1s^2 2s^2 2p^6 3s^2 3p^4$
    B. $1s^2 2s^2 2p^6 3s^2 3p^6$
    C. $1s^2 2s^2 2p^6 3s^1 3p^6$
    D. $1s^2 2s^2 2p^4 3s^2 3p^6$
    E. $1s^2 2s^2 2p^6 3s^3 3p^3$

12. What shape would you expect for SO_4^{2-} ion?
    A. trigonal planar
    B. trigonal pyramidal
    C. square planar
    D. linear
    E. tetrahedral

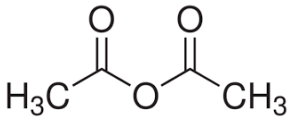
13. Which of the following substances is NOT able to form hydrogen bonds?
    A. H_2O
    B. glucose
    C. NH_3
    D. HBr
    E. $(CH_3)_2NH$

14. Choose the correct statement.
    A. Increasing number of covalent bonds between two atoms results in decreasing bond lengths.
    B. Covalent bonding is an attraction between oppositely charged ions.
    C. Nonpolar covalent bonds are formed when electrons are not shared equally.
    D. Water is a polar molecule because hydrogen is more electronegative than oxygen.
    E. When the electronegativity difference between two atoms is close to zero, the bond is polar.

5. Which of the following statements is true for the dissociation of a strong acid (HA) in water?
    A. Strong acids in aqueous solution dissociate almost entirely to A^- ions.
    B. The pH of strong acids is close to 14.
    C. At equilibrium $[A^-] << [HA]$.
    D. The percent dissociation of strong acids is low.
    E. At equilibrium $[A^-] << [H^+]$

16. The heat of formation of an element is:
    A. infinite
    B. zero
    C. always negative
    D. always positive
    E. either positive or negative

17. The molecule presented by the picture on the right is called:
    A. acetoacetate
    B. acetic anhydride
    C. ethylacetate
    D. dimethylester
    E. dimethylether



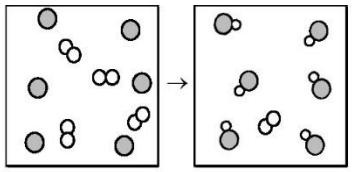
18. Which of the followings is an aromatic compound?
    A. decaline
    B. cyclohexene
    C. pyrrole
    D. tetrahydrofuran
    E. quinone

19. The following pairs of molecules represent:
    A. stereoisomers
    B. constitutional isomers
    C. enantiomers
    D. *cis-trans* isomers
    E. functional group isomers

20. Choose the one with the highest boiling point.
    A. CH_3-OH
    B. CH_3-CH_2-OH
    C. CH_3-CH_3
    D. CH_3-CH_2-CH_3
    E. CH_3-CH=CH_2

Section II.A.

1. The following diagram represents the reaction of A_2 (unshaded spheres) with B (shaded spheres). **(3)**



1p each

1.a. Write a balanced equation for the reaction.

2.b. Identify the limiting reactant.

2.c. How many moles of product can be produced from the reaction of 1.0 mol of A_2 and 1.0 mol of B?

2. Oxygen gas is commonly sold in 40.0 L steel containers at 19.5 ^oC and at a pressure of 124 atm. **(5)**

2.a. What volume in liters would the gas occupy at a pressure of 1.09 atm if its temperature remained unchanged?

2.b. What is the volume of the gas if its temperature was raised from 19.5 °C to 37.5 °C at constant pressure of 124 atm?

3. Write reaction equation for the Brønsted-Lowry acid-base reaction between ammonia and hydrochloric acid. Identify the conjugate acid-base pairs. **(2)**

Section II. B.

1. Draw structures and appropriate names to illustrate **(6)**

1.a. geometrical isomer pair of the unsaturated compound with molecular formula C_4H_8

1.b. enantiomers of lactic acid

1.c. keto-enol tautomers of acetone

2. Fill in the gaps in the following sentences. **(4)**

Molecules of primary and secondary amines can form…….. to each other, while tertiary amines cannot. For that reason, …… amines have the lowest boiling points among isomeric amines.

In aqueous solution aliphatic amines act as Brønsted-Lowry ……. .

Aldehydes and ketones react with primary amines to yield …… .